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MOVEMENTS AND HOME RANGES OF MOUNTAIN PLOVERS RAISING BROODS IN THREE COLORADO LANDSCAPES

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ABSTRACT.—We report movements and home-range sizes of adult Mountain Plovers (*Charadrius montanus*) with broods on rangeland, agricultural fields, and prairie dog habitats in eastern Colorado. Estimates of home range size (95% fixed kernel) were similar across the three habitats: rangeland (146.1 ha ± 101.5), agricultural fields (131.6 ha ± 74.4), and prairie dog towns (243.3 ha ± 366.3). Our minimum convex polygon estimates of home-range size were comparable to those on rangeland reported by Knopf and Rupert (1996). In addition, movements—defined as the distance between consecutive locations of adults with broods—were equivalent across habitats. However, our findings on prairie dog habitat suggest that home-range size for brood rearing may be related to whether the prairie dog habitat is in a complex of towns or in an isolated town. *Received 14 November 2003, accepted 4 February 2005.*

The Mountain Plover (*Charadrius montanus*) breeds primarily in the shortgrass prairies of Colorado, Wyoming, and Montana (Graul and Webster 1976) but breeds as far north as Canada and as far south as Mexico (e.g., Graul and Webster 1976, Day 1994, Knopf 1996, Shackford et al. 1999, Manning and White 2001). Colorado is considered the continental stronghold for Mountain Plovers, with over 60% of the population believed to breed there (Kuenning and Kingery 1998). The habitat types used by breeding Mountain Plovers within shortgrass prairie may contain areas grazed by native herbivores, such as bison (*Bison bison*) and black-tailed prairie dogs (*Cynomys ludovicianus*), or domestic herbivores, including cattle and sheep. Mountain Plovers also nest in agricultural fields (Knopf 1996, Knopf and Rupert 1999, Shackford et al. 1999). Landscape-level habitat use by breeding Mountain Plovers may be influenced by the distribution of these habitat types.

Landscape-level characteristics, such as the size, distribution, shape, and availability of different habitat types, are important to a species' population dynamics and regulation (Kareiva 1990, McKelvey et al. 1992, Schmiegelow and Monkkonen 2002, Crozer and Niemi 2003). The distribution of individuals among habitats reflects an ability to discriminate between habitat types and assess habitat quality (Pöysä et al. 2000), and differences in habitat affinity may partially explain the wide range of avian responses to loss of native habitat (Sekercioglu et al. 2002). Landscape configuration and proximity of resources provided by different habitat types may be critical to the breeding success of Mountain Plovers. Suitable breeding habitats minimize the energetic costs of foraging and reduce exposure to predators (Pöysä et al. 2000). Here, we report the relationship between movements and home-range sizes of Mountain Plovers during the brood-rearing period within three different habitat types.

METHODS

Information on brood-rearing activity of Mountain Plovers was collected in eastern Colorado from 2001 to 2003 during other ongoing studies in three different habitat types: rangeland, black-tailed prairie dog towns, and agricultural fields. In high-elevation (2,600–3,500 m) rangeland in Park County, Colorado, the habitat consisted primarily of slimstem muhly (*Muhlenbergia filiculmis*), and, to a lesser extent, blue grama (*Bouteloua gracilis*) grazed by domestic bison or cattle (Wunder et al. 2003). Our prairie dog study areas, located in Lincoln and Weld counties in eastern Colorado (also characterized as rangeland) were dominated by blue grama and buffalograss

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(*Buchloe dactyloides*). Only 1.94% of eastern Colorado is occupied by prairie dogs (White et al. 2005), and, in our study area, we knew of only one prairie dog complex (>10,000 ha)—a network of small (mean = 80 ha; range = 1–340 ha), active prairie dog towns within 800 m of each other. The agricultural field habitats were primarily composed of winter wheat strips interspersed with fallow fields in Weld County. The agricultural fields were >256 ha and located in areas with high concentrations of other agricultural fields. We were unable to address among-year variation in movements or home-range size because each year we conducted our study on a different habitat type: rangeland in 2001, agricultural fields in 2002, and prairie dog habitat in 2003.

To investigate Mountain Plover movements and home-range size, we attached 2.2-g radio transmitters (Advanced Telemetry Systems, Isanti, Minnesota) to nesting adult plovers at, or just before, hatching of eggs. We used walk-in box traps made of mesh wire to capture adult plovers at their nests. We placed radio transmitters on adults in each of the three habitats: 35 birds in rangeland (2001), 26 in agricultural fields (2002), and 15 in prairie dog habitat (2003). Body mass of adult Mountain Plovers ranges from 90 to 110 g (Knopf 1996); thus, transmitters were ≤2.4% of their body mass. A transmitter was affixed by applying a light coating of waterproof epoxy (Ace, Starbrite, or Devcon) to the transmitter and then sliding it under the upper back feathers. This attachment procedure allowed the transmitters to drop off when the birds later molted those feathers. Battery life of the transmitters was expected to be 56 days.

Using a hand-held Yagi antenna, each day we attempted to locate adults with broods to record the presence of (and count) chicks and record their location and habitat. Due to adverse weather conditions, however, data for some locations were collected at 2-day intervals. First, we located birds from greater distances (up to 800 m) to avoid forcing brood movements caused by human disturbance. After recording observer coordinates and distance and bearing to each adult with a brood, we approached (usually by walking) the birds to confirm their location via visual observation. Adults with broods were located until their chicks fledged, 36 days post-hatch (Miller and Knopf 1993). Adults with broods that did not successfully fledge at least one chick were not included in our analysis.

To calculate brood home-range sizes, we used the fixed-kernel method (Worton 1995, Seaman and Powell 1996) with a smoothing parameter chosen by least squares cross validation. This nonparametric technique depicts irregular distributions more accurately and produces home-range estimates with less bias relative to other home-range estimators (Seamen and Powell 1996). Home-range values were based on 50 and 95% contour intervals, hereafter referred to as "core area" and "home range," respectively (Bogner and Baldassarre 2002, Vega Rivera et al. 2003). Movement was defined as the distance moved between two consecutive locations. We also calculated minimum convex polygon home ranges, the minimum amount of area used to raise broods, for comparison with an earlier study (Knopf and Rupert 1996). Means are presented ± SD.

RESULTS AND DISCUSSION

Home range.—We monitored 12 broods on rangeland in 2001, 13 broods on agricultural fields in 2002, and 10 broods on prairie dog habitat (2 broods on the prairie dog complex, 8 on prairie dog towns) in 2003. Analyses were based on a mean of 20.3 ± 3.8 locations per brood in rangeland (range = 18–28), 28.7 ± 5.2 locations per brood in agricultural fields (range = 23–34), and 26.3 ± 6.6 locations per brood in prairie dog habitat (range = 19–33). Home-range estimates for the three habitats were relatively comparable for rangeland (146.1 ha ± 101.5), agricultural fields (131.6 ha ± 74.4), and prairie dog towns (243.3 ha ± 366.3).

Although mean point estimates of the core area on prairie dog towns were >2× those on rangeland and agricultural fields, confidence intervals between the three habitat types overlapped (Table 1). The larger point estimates in home range and core area on prairie dog habitat could be attributed to two birds, both of which raised their broods on the prairie dog complex. One had an estimated home range of 1,156.5 ha and a core area of 210.8 ha, and the other had a home range of 630.0 ha and a core area of 114.4 ha. Removing the data for

TABLE 1. Mean home-range size (ha) and movements of Mountain Plover adults with broods on rangeland (n = 12 broods), agricultural fields (n = 13), and prairie dog habitats (n = 10) in eastern Colorado from 2001 to 2003. Home-range size was based on 50% and 95% fixed kernel (FK) and minimum convex polygon (MCP) home-range estimates.

Habitat (year)	No. locations		50% FK		95% FK		MCP		Movement (m)	
	Mean	SD	Mean	SD (95% CI)	Mean	SD (95% CI)	Mean	SD (95% CI)	Mean	SD (95% CI)
Rangeland (2001)	20.3 (18–28)[a]	3.8	21.8	12.2 (14.9, 28.6)	146.1	101.5 (18.6, 203.5)	66.5	44.4 (41.4, 91.7)	482.3	165.0 (389.0, 575.7)
Agricultural fields (2002)	28.7 (23–34)[a]	5.2	19.9	14.2 (12.1, 27.6)	131.6	74.4 (19.1, 172.0)	90.3	53.6 (61.1, 119.4)	411.3	131.1 (340.0, 482.5)
Prairie dog habitat (2003)	26.3 (19–33)[a]	6.6	44.8	66.8 (3.5, 86.2)	243.3	366.3 (16.2, 470.3)	115.5	169.2 (10.6, 220.4)	422.9	174.9 (314.4, 531.3)

[a] Range of number of telemetry locations.

these two birds yielded a home range of 80.8 ha ± 42.8 and core area of 15.4 ha ± 10.7 on prairie dog towns. The other eight radio-marked birds and their broods were located on smaller, isolated prairie dog towns surrounded by shortgrass prairie that was either ungrazed or lightly grazed by cattle.

Minimum convex polygon (MCP) home ranges on rangeland, agricultural fields, and prairie dog habitat were comparable to those reported by Knopf and Rupert (1996) for rangeland habitat (56.6 ha ± 21.5, CI = 39.4–73.8). Although there are inherent biases with MCP, such as those generated when exploited areas are large (Kenward 1987), the overlapping confidence intervals in home ranges among habitat types suggest that Mountain Plovers raising broods use comparably sized patches within very different landscapes.

Movements.—Movement, defined as the distance between consecutive locations of adults with broods, was similar across habitats. Birds that nested in rangeland habitats of Park County remained on rangeland; they did not move their broods to other habitats. However, the landscape of Park County has changed very little over the past century; ranching is still the primary land-use practice and there are few or no agricultural fields or prairie dog towns to which birds could have moved (Wunder et al. 2003).

Plovers that nested on agricultural fields exhibited no obvious patterns with respect to moving their broods. Some individuals (n = 4) stayed on agricultural fields, while others moved to adjacent or nearby rangeland (n = 4) or moved back and forth between agricultural fields and rangeland (n = 5). It may be that when conditions are dry, invertebrate prey and/or cover are depauperate, resulting in these among-habitat movements. In the year we studied brood-rearing activity on agricultural fields in Weld County (2002), our study area experienced extreme drought conditions (National Drought Mitigation Center 2004). The vegetation on both agricultural fields and rangeland was relatively short and sparse compared with years when weather conditions were normal or wet (VJD pers. obs.).

No plovers that nested in prairie dog habitat moved their broods to other habitat types. The weather conditions for the year of the prairie dog study (2003) were categorized as wet dur-

ing the breeding season (National Drought Mitigation Center 2004), which resulted in taller and denser vegetation on prairie dog habitat (VJD pers. obs.). The increase in vegetation may have provided more concealment for plovers or increased prey resources; thus, perhaps, adults did not need to seek out other habitats in order to successfully fledge their broods.

Movements were similar for all 3 years and habitats (Table 1). Movements of the two adults and broods with the largest home ranges on prairie dog habitat were 690.7 and 589.9 m, within the range of movements observed in all habitats (175.6–800.1 m). Additionally, movements did not appear to be related to size of home range or core area. For example, one adult nested on a small prairie dog town approximately 200 ha in size. Its home range (132.4 ha) and core area (34.9 ha) were relatively small, but its movements were similar (604.2 m) to those of other adults with broods.

Because our study was conducted in three different habitats, each in a different year, and because our sample sizes were small, we cannot validate any inferences between habitats, sites, or years for home-range estimates or movement patterns. Our findings from prairie dog habitat suggest that home range and core area used by Mountain Plovers for brood rearing may be related to the size of prairie dog habitat; movement distances were not related to prairie dog habitat size. In Montana, adult plovers with broods are not known to move between prairie dog towns (Dinsmore et al. 2002); in Colorado, however, we did observe adults with broods move between prairie dog towns within a complex of prairie dog towns. We conclude that prairie dog complexes are likely more favorable for Mountain Plover brood-rearing activity than isolated prairie dog towns. Similarly, Biggins et al. (1993) suggested that the prairie dog complex, and not the prairie dog town, is the habitat unit selected by black-footed ferrets (*Mustela nigripes*).

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